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(54) [Title of Invention] STRUCTURE WITH BUILT-IN SEMICONDUCTOR CIRCUIT

(54) [Abstract]
[Problem to be Solved]
To avoid a problem with a conventional transfer technique by employing a means of embedding a transfer substrate to which a thin film semiconductor integrated circuit is transferred in advance to a structure such as a card substrate to combine the two, as well as to make the transfer substrate indistinguishable and not extractable from an object body by selecting a material of the transfer substrate from those that are of the same quality as the object body to which a transfer substrate such as an IC card substrate is applied.

[Means of Solving the Problem]

A card substrate 20 over which a conductive pattern 30 is formed, and a transfer substrate 34 to which a thin film semiconductor integrated circuit is transferred are provided. The thin film semiconductor circuit transferred to the transfer substrate is combined with a card substrate so as to be electrically connected to the conductive pattern. An IC card 10 is provided, which includes the card substrate and the transfer substrate which are formed of materials of the same quality which cannot be distinguished and etched.

[Claims]

[Claim 1]

A structure with a built-in semiconductor circuit made by combining a transfer substrate to which a thin film semiconductor integrated circuit is transferred and a structure, wherein a constituent material of the structure and a constituent material of the transfer substrate are materials of the same quality.

[Claim 2]

The structure according to claim 1, wherein the structure is an IC card substrate.

[Claim 3]

The structure according to claim 1 or 2, wherein the structure and the transfer substrate are each made of a synthetic resin.

[Claim 4]

The structure according to any one of claims 1 to 3, wherein the structure and the transfer substrate are both dyed to have the same or similar dark color.

[Claim 5]

The structure according to claim 3, wherein the structure and the transfer substrate are made of materials that are etched at the same time with respect to the same solvent.

[Claim 6]

An IC card provided with a card substrate over which a conductive pattern is formed and a transfer substrate to which a thin film semiconductor integrated circuit is transferred, wherein:

the transfer substrate is combined with the card substrate so that the thin film semiconductor circuit transferred to the transfer substrate is electrically connected to the conductive pattern, and

the card substrate and the transfer substrate are formed of materials of the same quality which cannot be distinguished and etched.

[Claim 7]

The IC card according to claim 6, wherein the card substrate and the transfer substrate are made of materials that are etched at the same time with respect to the same solvent.

[Claim 8]

The IC card according to claim 7, wherein the card substrate and the transfer substrate are each made of a synthetic resin.

[Claim 9]

The IC card according to any one of claims 6 to 8, wherein the transfer substrate is covered by a nontransparent film.

[Claim 10]

The IC card according to any one of claims 6 to 8, wherein the transfer substrate is thermally laminated by the nontransparent film.

[Claim 11]

The IC card according to claim 9 or 10, wherein the film is made of the same material as that of the card substrate and a transfer layer.

[Claim 12]

The IC card according to any one of claims 6 to 11, wherein the card substrate and the transfer substrate are each made of a thin and flexible material.

[Claim 13]

A manufacturing method of an IC card in which a semiconductor integrated circuit is combined with a card substrate, wherein:

the thin film semiconductor integrated circuit is formed over a manufacture substrate;

the integrated circuit is separated off from the manufacture substrate and transferred to a transfer substrate made of a material of the same quality as the card substrate, and

the transfer substrate is combined with the card substrate over which a conductive pattern is formed so that an electrode-exposed portion of the semiconductor integrated circuit is connected to the conductive pattern.

[Detailed Description of the Invention]

[Field of the Invention]

The present invention relates to a structure with a built-in semiconductor circuit such as an IC card, and a manufacturing method thereof.

[Conventional Art]

As an IC card that includes a semiconductor integrated circuit (IC), cards such as a memory card, an I/O (input/output circuit) card, and a card that is ISO compliant are known. Here, a card that is ISO compliant is an IC card that includes a microprocessor and a memory in an integrated circuit, and is used widely in medical care and finance because it can be made to have a security function. Also, a memory card is an IC card that includes only a memory and not a microprocessor in an integrated circuit, and is used widely as a portable storage device used in a personal computer, an electronic musical instrument, a game machine, and the like. An I/O card is an IC card that has various functions such as modem, LAN, and Ethernet, and is used widely as an input/output device that is attached and detached from a microcomputer or the like. This IC card was manufactured by first forming an IC using a silicon substrate and then combining the silicon IC chip with a substrate made of a resin by embedding or the like. On the other hand, the present applicant has suggested a transfer technique of forming a thin film semiconductor integrated circuit over a manufacture substrate that is repeatedly reused, that is, a silicon substrate, and then transferring the thin film semiconductor integrated circuit to another substrate (for example, Japanese Published Patent Application No. H11-74533). Furthermore, a manufacturing method of an IC card by which this thin film device is transferred to an IC card substrate itself has been suggested (Japanese Published Patent application No. H11-20360). This manufacturing method is excellent in the point that a light and thin IC card can be manufactured by transferring to a card substrate a transfer layer that includes a thin film integrated circuit formed over a manufacture substrate, as opposed to a conventional IC card that does not have favorable portability because the IC card becomes thick and hard because it includes a circuit substrate in addition to a silicon substrate that is a base for IC manufacture, in addition to this IC card becoming hard and heavy due to a point that the circuit substrate itself and a protection layer of the IC chip have to be formed relatively thick to protect the IC chip from external force.

[Problem to be Solved by the Invention]

Including the previously-mentioned IC card, in general an IC card has various confidential information recorded therein regarding a user of the IC card and an issuer of the IC card, and there is concern that in the case that the IC card is lost or stolen, these information are fraudulently read. That is, with a conventional IC card, because of a structure in which a semiconductor circuit formed over a silicon substrate is embedded in a card substrate made of a resin, by etching only the resin substrate, the semiconductor circuit over the silicon substrate can be selectively obtained and data in

the circuit can be analyzed. In other words, due to a large difference in terms of quality of material between the card substrate and the substrate over which the semiconductor circuit is formed, the semiconductor circuit substrate can be distinguished from the card substrate, and there is a problem that a fraudulent acquirer of the IC card can take out the semiconductor circuit and obtain electronic information in the semiconductor integrated circuit. On the other hand, in a method of directly transferring a thin film device to a card substrate, there is a problem in terms of manufacturing an IC card such as having to have to align an exposed electrode of a thin film semiconductor integrated circuit to a conductive pattern of the IC card and transfer the thin film semiconductor circuit to a card substrate. Furthermore, in the case that the card substrate is made of a flexible material, it was difficult to separate off a transfer layer from a transfer substrate over which this transfer layer was formed while maintaining adhesion between the transfer layer and the card substrate because the card substrate would bend or the like. Also, in a conventional example of this transfer method, consideration with respect to a problem point in terms of material quality between the substrate and the transfer substrate is not mentioned. In view of this, to solve such problems, an object of the present invention is to avoid a problem with a conventional transfer technique by employing a means of embedding a transfer substrate to which a thin film semiconductor integrated circuit is transferred in advance to a structure such as a card substrate to combine the two, as well as to make the transfer substrate indistinguishable and not extractable from an object body by selecting a material of the transfer substrate from those that are of the same quality as the object body to which a transfer substrate such as an IC card substrate is applied. Also, another object of the present invention is to provide a light and thin IC card that is difficult to steal and use information inside.

[Means for Solving the Problems]

In order to achieve these objects, the present invention is a structure with a built-in semiconductor circuit made by combining with a structure a transfer substrate to which a thin film semiconductor integrated circuit is transferred, and a constituent material of this structure and a constituent material of the transfer substrate are materials of the same quality. As the structure, an IC card substrate is typical. Alternatively, various object bodies that need electronic information may be used. Another example of a combination of a structure and a transfer substrate is an aspect in which a substrate to which a resonance circuit is transferred is embedded into a costly good such as an electronic product instead of a resonance tag. In a favorable aspect of the present

invention, the structure and the transfer substrate are each made of a synthetic resin. If the structure and the transfer substrate are both dyed to have the same or similar dark color, there is an advantage that a semiconductor integrated circuit pattern over the transfer substrate cannot be observed from outside because it is masked by the color. It is preferable that the structure and the transfer substrate are made of materials that are etched at the same time with respect to the same solvent. Further, it is preferable that they be formed of the same synthetic resin. In the present invention, an IC card is provided with a card substrate over which a conductive pattern is formed and a transfer substrate to which a thin film semiconductor integrated circuit is transferred, and the transfer substrate is combined with the card substrate so that the thin film semiconductor circuit transferred to the transfer substrate is electrically connected to the conductive pattern, and the card substrate and the transfer substrate are formed of materials of the same quality which cannot be distinguished and etched. It is preferable that the transfer substrate is covered by a nontransparent film or laminated. This film preferably has the same color or a similar color to a background color of the card substrate. In a preferred embodiment of the present invention, the card substrate and the transfer substrate are each made of a thin and flexible material. Also in the present invention, in a manufacturing method of an IC card in which a semiconductor integrated circuit is combined with a card substrate, the thin film semiconductor integrated circuit is formed over a manufacture substrate; the integrated circuit is separated off from the manufacture substrate and transferred to a transfer substrate made of a material of the same quality as the card substrate; and the transfer substrate is combined with the card substrate over which a conductive pattern is formed so that an electrode-exposed portion of the semiconductor integrated circuit is connected to the conductive pattern.

[Embodiment Mode of the Invention]

Next, an embodiment mode of the present invention is described with reference to drawings. One example of an IC card is described with reference to FIG. 1. In FIG. 1, a block diagram of a ROM (read-only memory) card is shown. In FIG. 1, a connector 12, an I/O 14, and a ROM 16 are provided over a card substrate. Here, the connector 12 becomes connected to a terminal on a host system side when a ROM card 10 is inserted into a card slot of the host system. In the connector 12, a power source terminal 12A, a ground terminal 12B, control terminals 12C and 12D, an address terminal 12E, and a data terminal 12F are provided. Furthermore, the power source terminal 12A, the input/output circuit (I/O) 14, and the ROM 16 are connected by a

wiring 18A; the ground terminal 12B, I/O 14, and the ROM 16 are connected by a wiring 18B, the remaining terminals 12C to 12F and the connector 12 are connected by a wiring 18C; and the I/O 14 and the ROM 16 are connected by a wiring 18D. The I/O 14 is provided between the connector 12 and the ROM 16, and includes a decoder circuit, an input circuit, and an output circuit. When the ROM card 10 is inserted into the card slot of the host system, electrical power is supplied to the I/O 14 and the ROM 16 through the power source terminal 12A and the ground terminal 12B. Furthermore, when a control signal and an address signal from the host system are input to the I/O 14 through the control terminals 12C and 12D and the address terminal 12E, an address specification signal for specifying an address of the ROM 16 is supplied to the ROM 16 through the in put circuit and the decoder circuit. Data that is read from the ROM 16 in correspondence to the address is output from the ROM card 10 in a specification compliant to a standard of the host system through the output circuit and the decoder circuit of the I/O 16 and the data terminal 12F. Among constituent elements shown FIG. 1, each of the terminals 12A to 12F and the wirings 18A to 18C are formed over the card substrate 20 or inside the card substrate as shown in FIG. 2. Here, a material of the card substrate 20 is a light, relatively thin, and a plate-form insulating substrate such as a synthetic resin such as plastic or a glass substrate. An integrated circuit portion including the I/O 14, the ROM 16, and the wirings 18D and the like connecting them shown in FIG. 1 is transferred to a transfer layer substrate. When this transfer substrate is combined with the card substrate by being stored in a storage hole provided in the card substrate, a terminal formed on the card substrate and an electrode terminal of the exposed integrated circuit are conductively bonded with a conductive adhesive. A state in which the transfer substrate is combined with the card substrate is described using FIG. 3. FIG. 3(A) is a schematic view (a plan view) of the card substrate. Reference numeral 30 schematically denotes a conductive pattern of a wiring, a terminal, a coil, and the like provided over the card substrate 20, and reference numeral 32 denotes the storage hole in which the transfer substrate is stored. When the transfer substrate over which a semiconductor substrate in a thin-film form is transferred is inserted in this storage hole, an electrode with an exposed semiconductor integrated circuit is connected to the terminal of the conductive pattern. FIG. 3(B) shows a cross-sectional view of FIG. 3(A) along line b-b. Reference numeral 34 denotes the transfer substrate stored in a storage hole 32. In the storage hole, a conductive pattern that is to be conductive with a thin film device is placed, and when the transfer substrate is inserted into the storage hole, the conductive pattern and an exposed terminal of the transfer substrate are conductively connected to each other. Reference numeral 36

denotes a film that coats and protects a transfer layer of a semiconductor integrated circuit or the like transferred to the transfer substrate, and preferably the film is dyed to be the same color as the card substrate and made of the same material as the card substrate or the transfer substrate. Here, a reason for using a film that is dyed to have the same color as the card substrate is so that a semiconductor circuit pattern in a transfer body 16 cannot be observed with a microscope or the like from outside the card substrate. Note that it is preferable that the transfer body is thermally laminated with a film. Further, the card substrate itself to which the transfer body is applied may be coated or laminated with the same film. The transfer substrate 34 is made of a material that is of the same quality as a material of the card substrate 20. When etching of the card substrate 20 is attempted by dissolving in a solution, because the transfer substrate that makes up a main body of a semiconductor circuit is also etched at the same time, the semiconductor circuit itself is destroyed and the semiconductor circuit cannot be distinguished and extracted from the card substrate. Here, "of the same quality" means that the card substrate and the transfer substrate are etched with the same solution at the same time, that is, the materials are similar enough to a degree that they are dissolved at the same time, and it is preferable that they are both the same material, for example, polyethylene terephthalate (PET). Because PET is soluble with respect to acetone, when the card substrate is etched in acetone, the transfer substrate is also etched at the same time and it is difficult to extract the semiconductor integrated circuit from the card substrate. For a constituent material of the transfer substrate, various synthetic resins can be given. The constituent material may be either a thermoplastic resin or heat curing resin, for example, a polyolefin such as polyethylene, polypropylene, ethylene-propylene copolymer, or ethylene-vinyl acetate copolymer; cyclic polyolefin; modified polyolefin; polyvinyl chloride; polyvinylidene chloride; polystyrene; polyamide; polyimide; polyamide-imide; polycarbonate; poly-(4-methyl pentene-1); ionomer; acrylic resin, polymethylmethacrylate; acrylonitrile styrene copolymer (AS resin); butadiene-styrene copolymer; a polyester such as Ethylene Vinyl Alcohol (EVOH), Polyethylene Terephthalate (PET), Polybutylene Terephthalate (PBT), and Polycyclohexane Terephthalate (PCT); polyether; polyetherketone (PEK); polyetheretherketone (PEEK); polyetherimide; polyacetal (POM); polyphenyleneoxide; modified polyphenyleneoxide; polyarylate; aromatic polyester (liquid crystal polymer); polytetrafluoroethylene; polyvinylidene fluoride; other resin of fluorine series; various thermoplastic elastomer such as those of styrene series, polyolefin series, polyvinyl chloride series, polyurethane series, fluorine-containing rubber series, or chlorinated polyethylene series; epoxy resin, phenol resin; urea resin; melamine resin; unsaturated

polyester; silicone resin; polyurethane; or the like; or a copolymer, a blended body, a polymer alloy or the like mainly containing the material can be given, and one type or two or more types of these can be combined and used (for example, as a laminated body of two or more layers). The material forming the transfer substrate is selected from those that are of the same quality as the material forming the card substrate. Transferring a thin film device to the transfer substrate is carried out using a method mentioned in Japanese Published Patent Application No. H11-26733, for example. That is, a semiconductor device of a thin-film form is formed in stacks over a manufacture substrate that is repeatedly reused, such as heat resistance glass or quartz, and then the semiconductor device is separated from the manufacture substrate and transferred to the transfer substrate. Alternatively, the thin film device that is transferred to the transfer substrate once may be retransferred to a secondary transfer substrate, and the thin film device may be separated from a primary transfer substrate. The primary transfer substrate and the secondary transfer substrate are both used as the transfer substrate of the present invention. In the case that the transfer substrate is to be thin and flexible, the secondary transfer substrate is favorably used. As the thin film device, there are various semiconductor circuits made of a TFT mentioned in the previously-mentioned patent application. In the case that this semiconductor circuit is combined with the card substrate, an electrode that is to be a terminal is exposed in the semiconductor circuit, and made so that this electrode and a terminal of the card substrate are electrically connected. As the card substrate, a thin and flexible substrate can be used. At this time, the conductive pattern of the wirings and terminals is formed over the card substrate. A plan view of this card substrate is shown in FIG. 4(A). Reference Numeral 42 denotes a conductive region in which the transfer substrate is placed, and a terminal group that is electrically connected to the exposed terminal of the thin film device transferred to the transfer substrate is arranged. 40 is a flexible thin card substrate. FIG. 4(B) is a cross-sectional view of FIG. 4(A) along B-B. The transfer substrate is attached to the conductive region 42 of the flexible card substrate 40 with a conductive adhesive so that they are combined. The thin film device transferred to the transfer substrate is provided with an exposed electrode terminal that is connected to the conductive region 42. It is preferable that an entire thin film IC card to which a thin film transfer substrate is attached is laminated with a color film. The transfer substrate and the card substrate are formed of resin materials that are of the same quality and dyed with the same dark color. According to this embodiment, because the card substrate and the transfer substrate are both manufactured from flexible synthetic resins that are thin and flexible, an IC card with excellent

confidentiality of electronic information as well as excellent portability can be provided.

[Effect of the Invention]

As described above, according to the present invention, a problem with a conventional transfer technique is avoided by employing a means of embedding a transfer substrate to which a thin film semiconductor integrated circuit is transferred in advance to a structure such as a card substrate to combine the two, and the transfer substrate can be made indistinguishable and not extractable from an object body by selecting a material of the transfer substrate from those that are of the same quality as the object body to which a transfer substrate such as an IC card substrate is applied. Therefore, according to the present invention, a light and thin IC card that is difficult to steal and use information inside can be provided

[Brief Description of Drawings]

[FIG. 1] A plan view showing an example of an IC card;

[FIG. 2] A plan view showing a card substrate of an IC card;

[FIG. 3] A plan view and a cross-sectional view schematically showing a structure of a first example of an IC card;

[FIG. 4] A plan view and a cross-sectional view schematically showing a structure of a second example of an IC card.

[Explanation of Reference Numerals]

10 IC card
12 terminal
14 I/O
16 ROM
18A to 18D wiring
20 card substrate
22 to 29 wiring
30 conductive pattern
32 storage hole in which transfer substrate is stored
34 transfer substrate